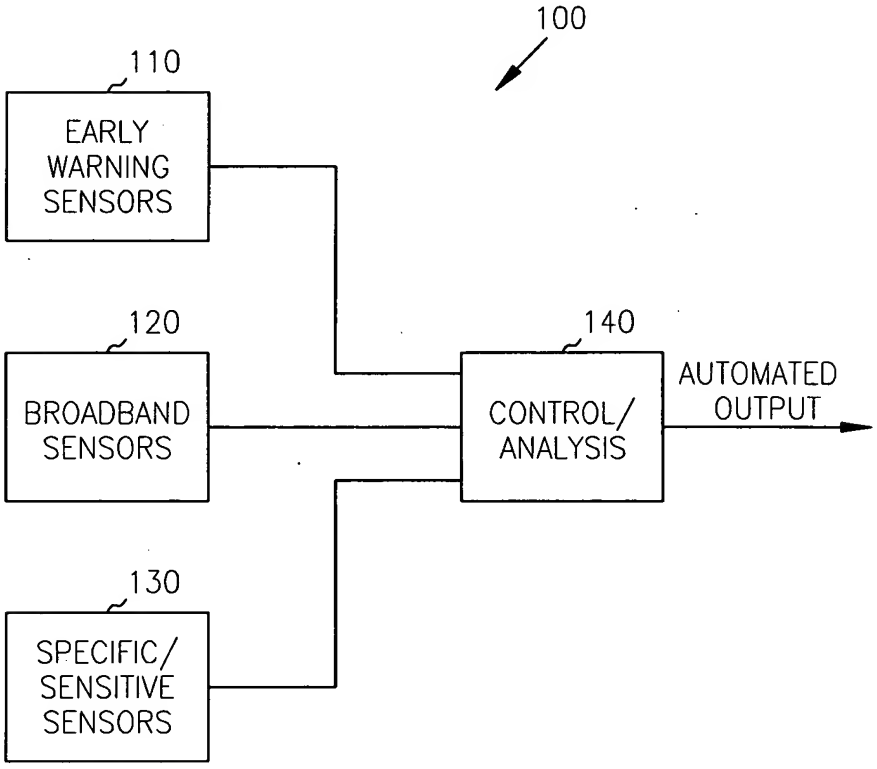
100
110
EARLY WARNING SENSORS
120
BROADBAND SENSORS
130
SPECIFIC/ SENSITIVE SENSORS
140
CONTROL/ ANALYSIS
AUTOMATED OUTPUT

FIG. 1

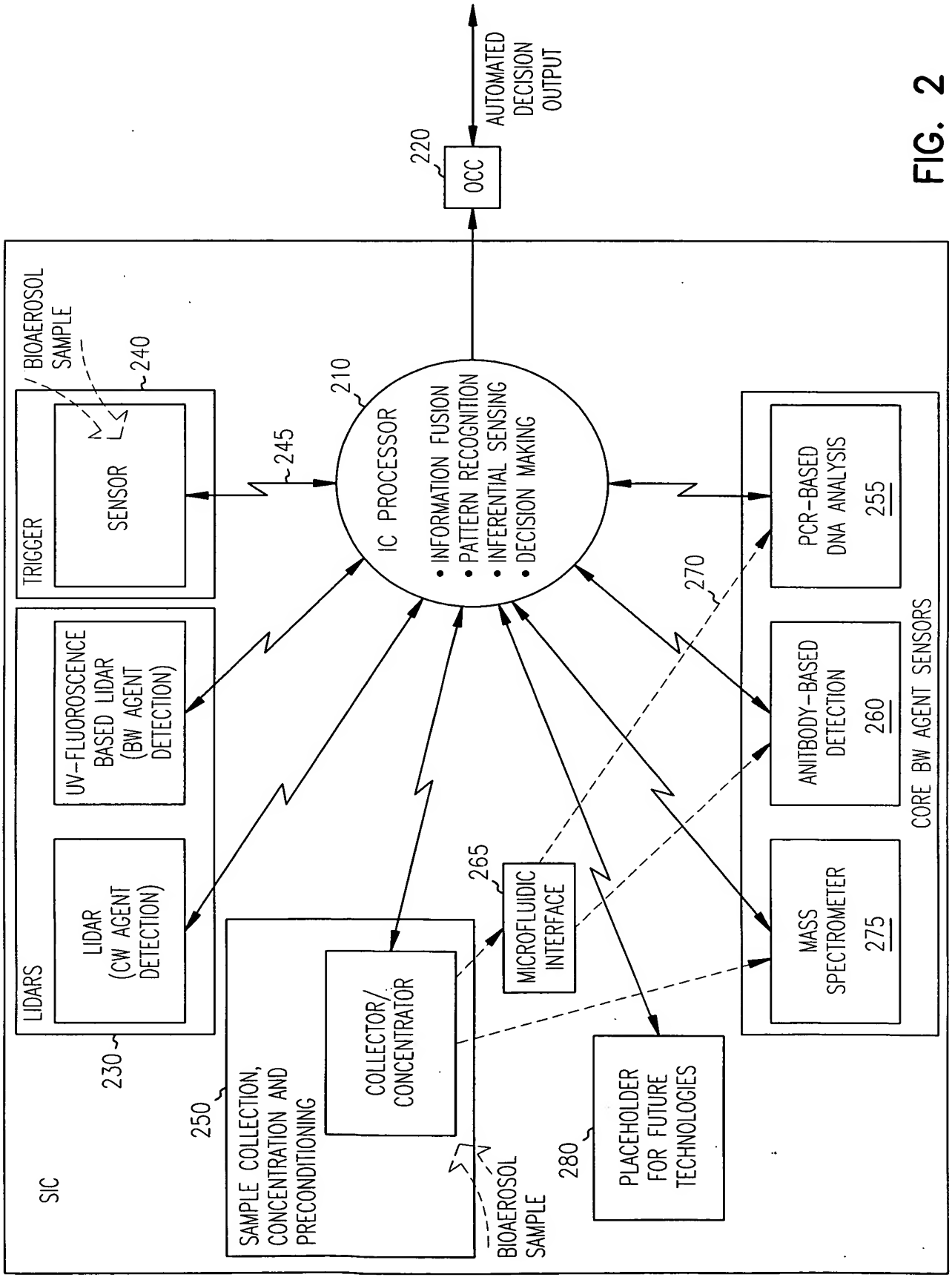
AUTOMATED DECISION OUTPUT
220
OCC
210
IC PROCESSOR
• INFORMATION FUSION
• PATTERN RECOGNITION
• INFERENTIAL SENSING
• DECISION MAKING
245
270
BIOAEROSOL SAMPLE
240
TRIGGER
SENSOR
LIDARS
UV-FLUOROSCENCE BASED LIDAR (BW AGENT DETECTION)
LIDAR (CW AGENT DETECTION)
230
CORE BW AGENT SENSORS
PCR-BASED DNA ANALYSIS 255
ANITBODY-BASED DETECTION 260
MASS SPECTROMETER 275
265
MICROFLUIDIC INTERFACE
SAMPLE COLLECTION, CONCENTRATION AND PRECONDITIONING
250
COLLECTOR/ CONCENTRATOR
BIOAEROSOL SAMPLE
280
PLACEHOLDER FOR FUTURE TECHNOLOGIES
SIC

FIG. 2

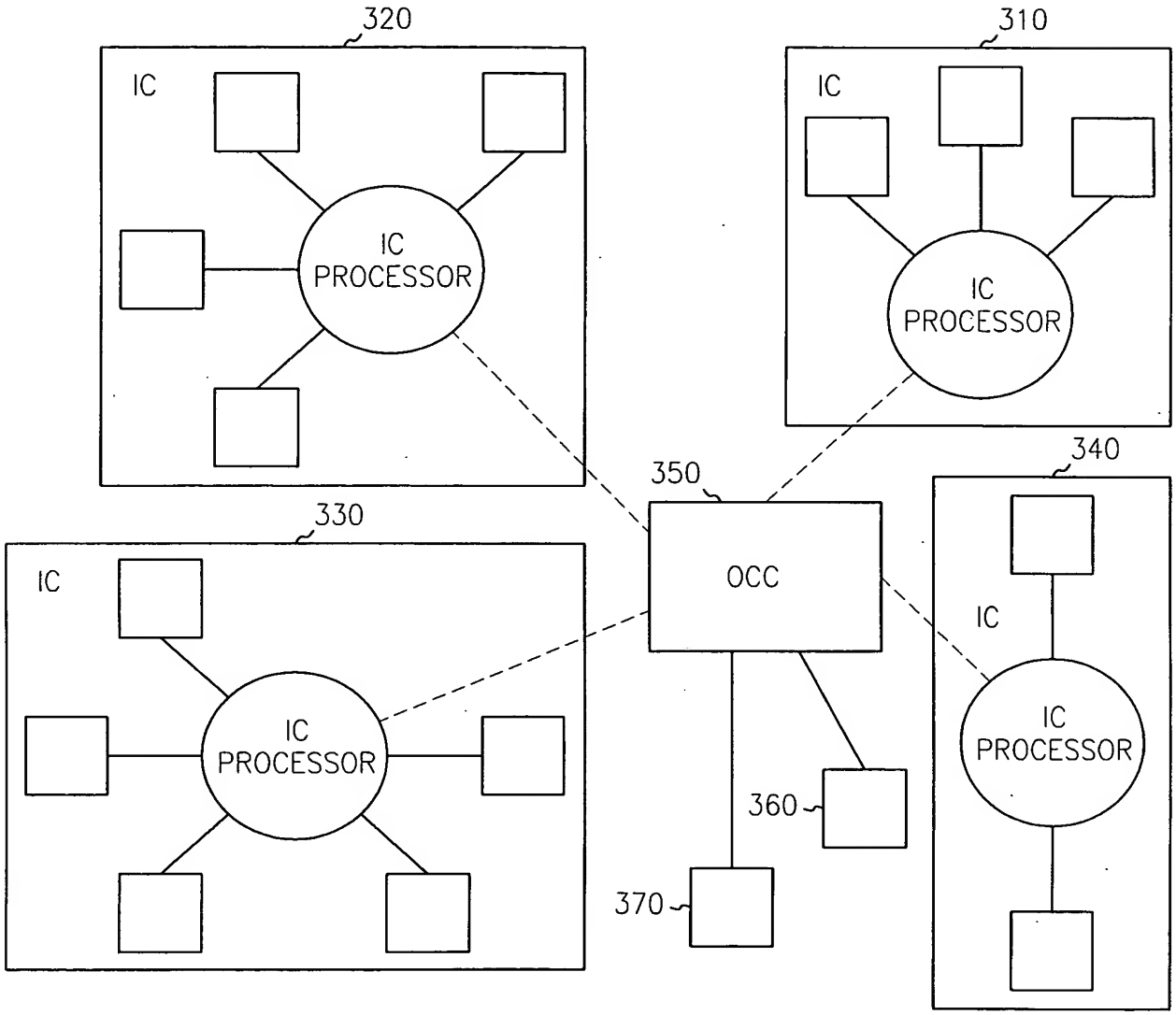
320
IC
IC PROCESSOR
310
IC
IC PROCESSOR
340
IC
IC PROCESSOR
350
OCC
330
IC
IC PROCESSOR
360
370

FIG. 3

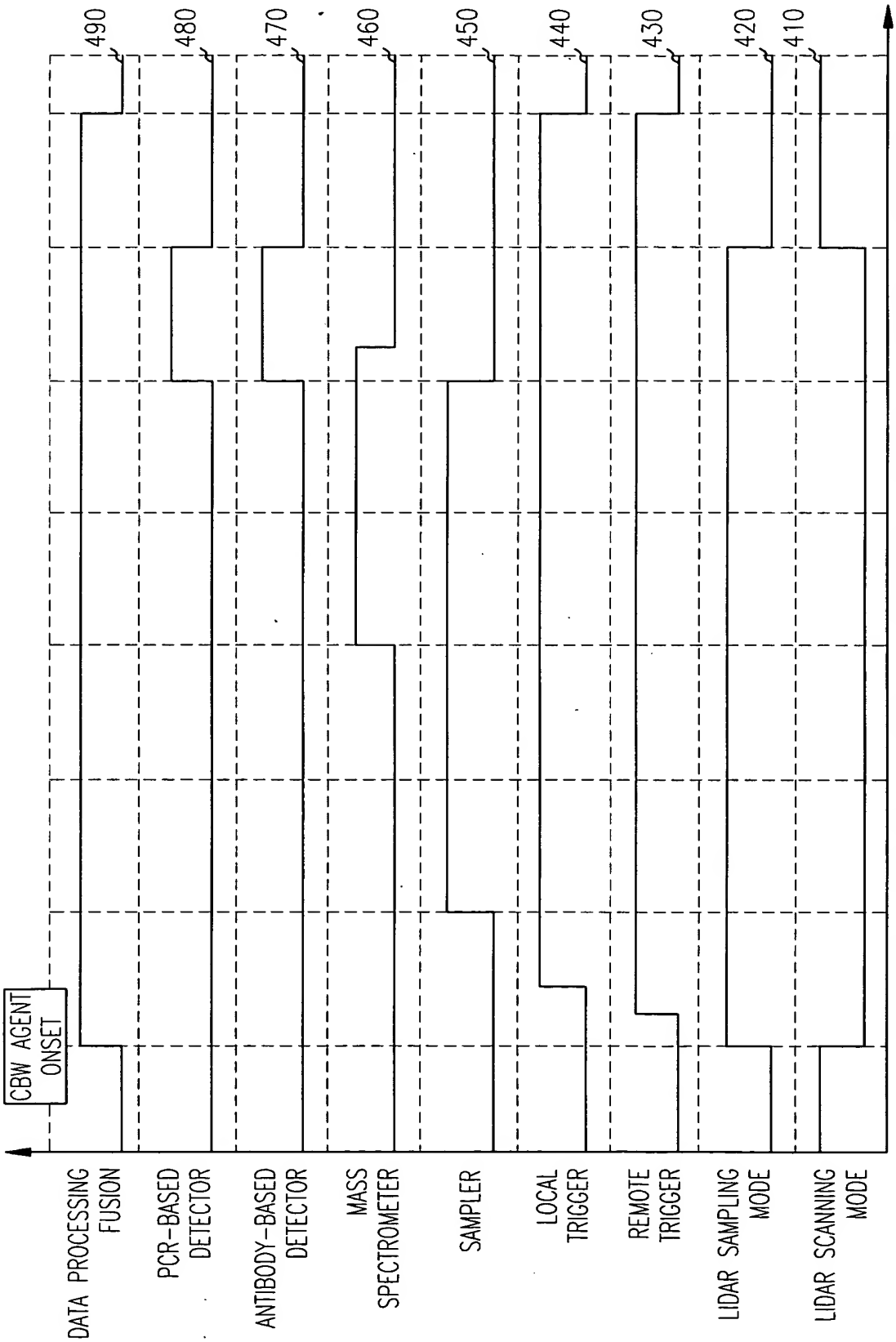
490
480
470
460
450
440
430
420
410
CBW AGENT ONSET
DATA PROCESSING FUSION
PCR-BASED DETECTOR
ANTIBODY-BASED DETECTOR
MASS SPECTROMETER
SAMPLER
LOCAL TRIGGER
REMOTE TRIGGER
LIDAR SAMPLING MODE
LIDAR SCANNING MODE
BIOWARFARE AGENT SIGHTING
SAMPLING AND CONCENTRATION START
SAMPLE INTRODUCTION INTO CORE CBW AGENT SENSORS
BROADBAND ANALYSIS
SAMPLING AND CONCENTRATION END
SPECIFIC ANALYSIS
AUTOMATED DECISION

FIG. 4

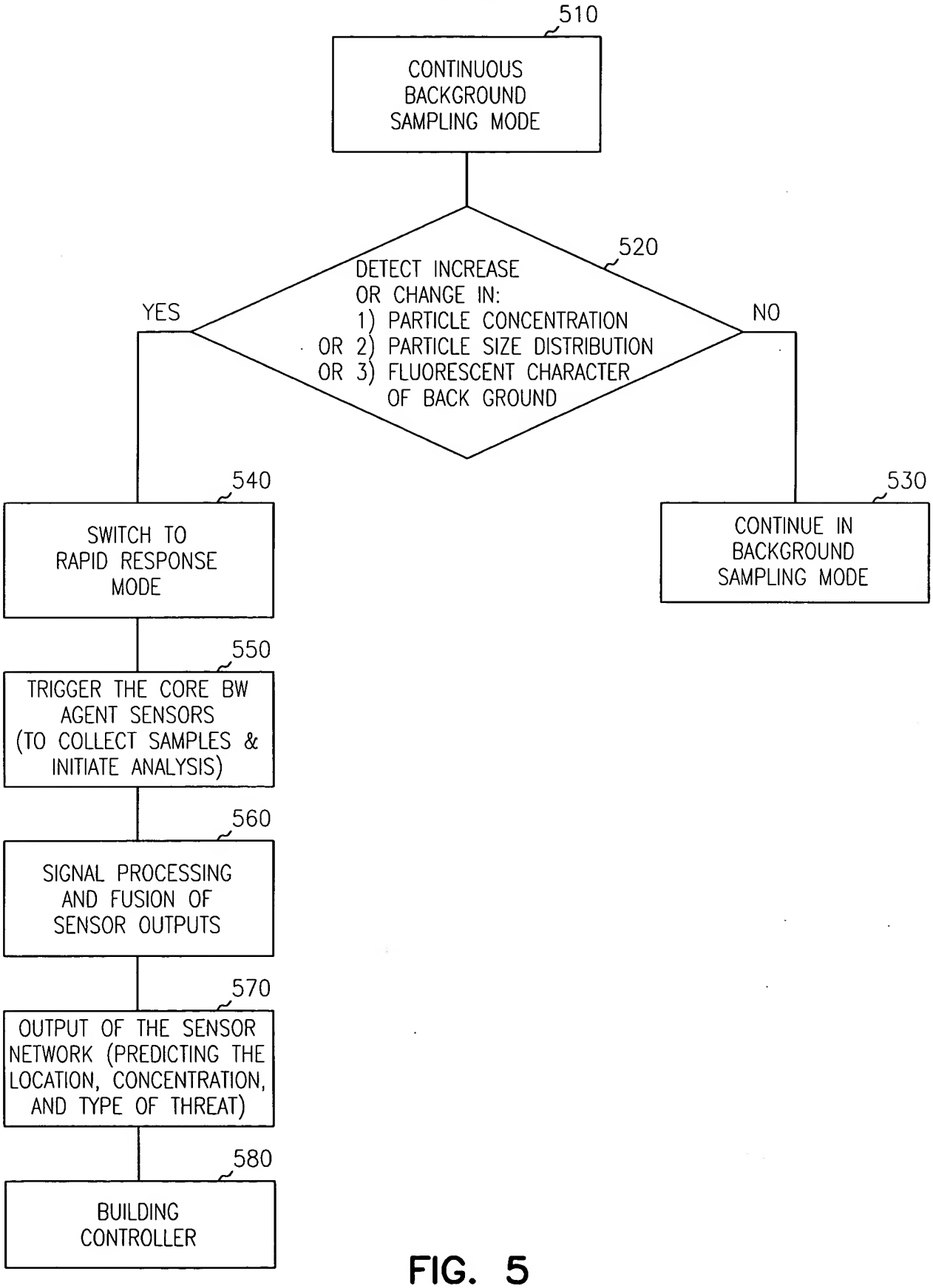
510
CONTINUOUS BACKGROUND SAMPLING MODE
520
DETECT INCREASE OR CHANGE IN:
1) PARTICLE CONCENTRATION
OR 2) PARTICLE SIZE DISTRIBUTION
OR 3) FLUORESCENT CHARACTER OF BACK GROUND
YES
NO
540
SWITCH TO RAPID RESPONSE MODE
530
CONTINUE IN BACKGROUND SAMPLING MODE
550
TRIGGER THE CORE BW AGENT SENSORS (TO COLLECT SAMPLES & INITIATE ANALYSIS)
560
SIGNAL PROCESSING AND FUSION OF SENSOR OUTPUTS
570
OUTPUT OF THE SENSOR NETWORK (PREDICTING THE LOCATION, CONCENTRATION, AND TYPE OF THREAT)
580
BUILDING CONTROLLER

FIG. 5

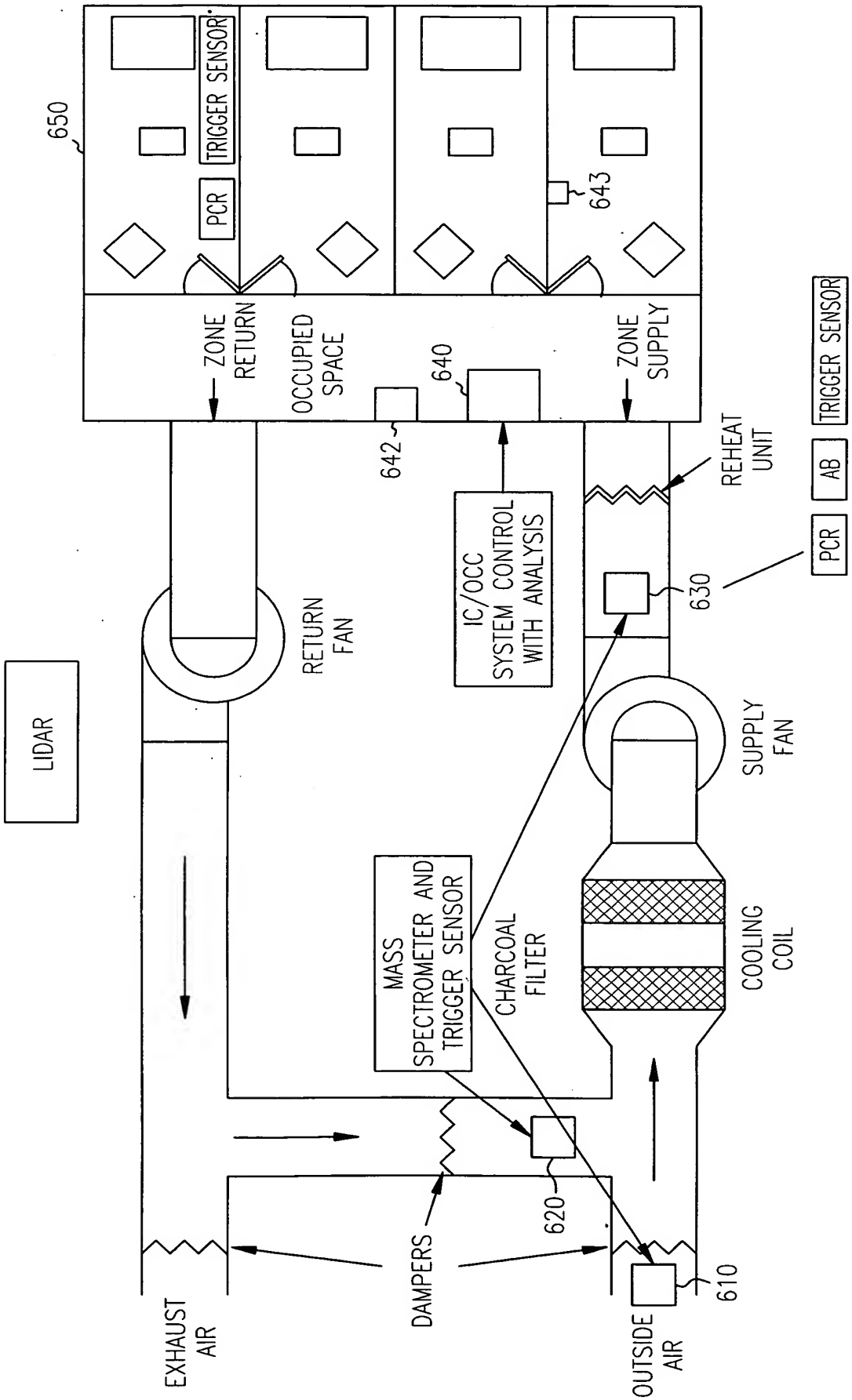
650
TRIGGER SENSOR
PCR
643
ZONE RETURN
OCCUPIED SPACE
640
642
ZONE SUPPLY
REHEAT UNIT
TRIGGER SENSOR
AB
PCR
630
IC/OCC SYSTEM CONTROL WITH ANALYSIS
RETURN FAN
LIDAR
SUPPLY FAN
MASS SPECTROMETER AND TRIGGER SENSOR
CHARCOAL FILTER
COOLING COIL
620
DAMPERS
610
EXHAUST AIR
OUTSIDE AIR

FIG. 6

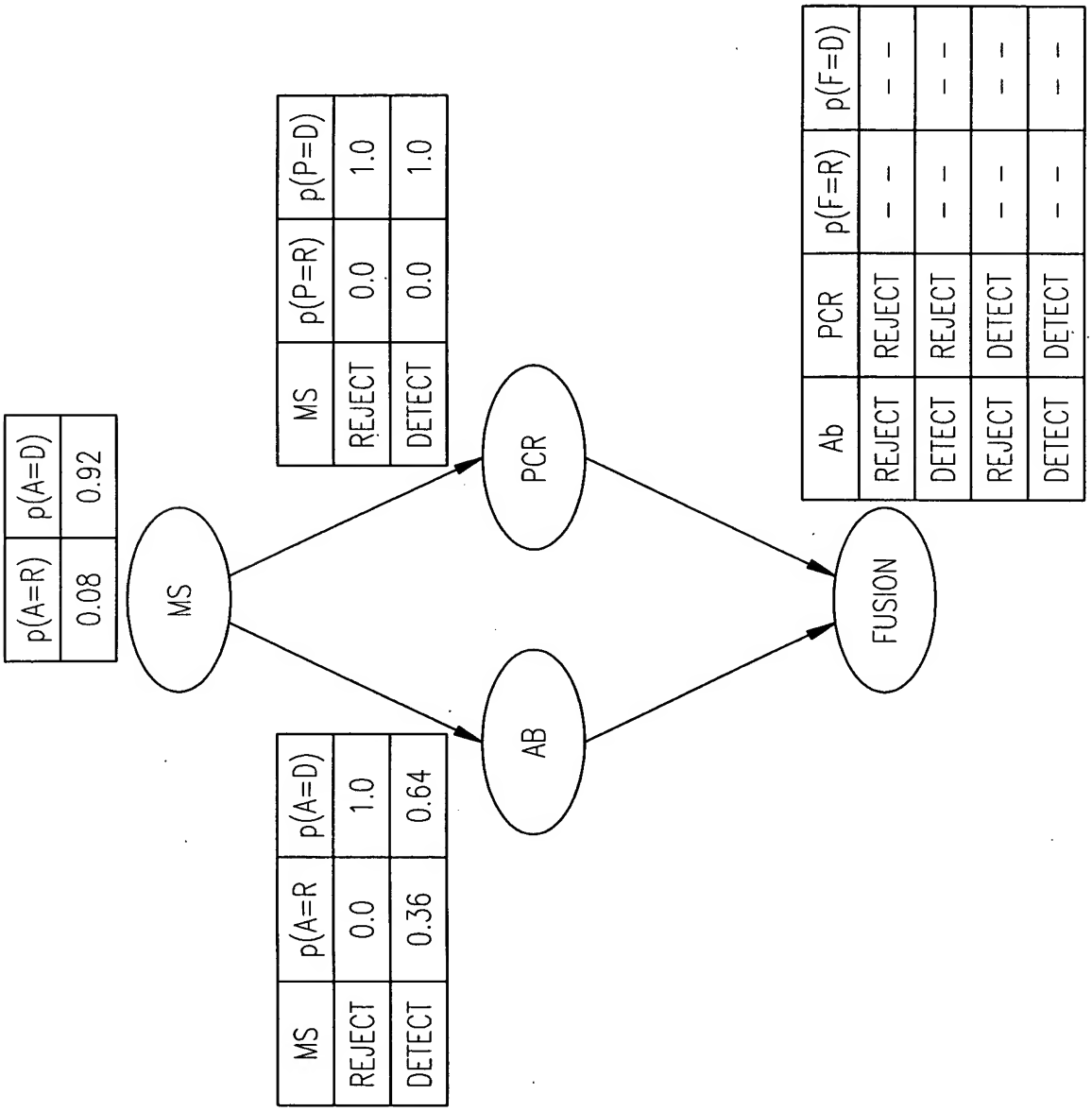
MS
PCR
AB
FUSION
p(A=R) 0.08
p(A=D) 0.92
MS | p(P=R) | p(P=D)
REJECT | 0.0 | 1.0
DETECT | 0.0 | 1.0
MS | p(A=R | p(A=D)
REJECT | 0.0 | 1.0
DETECT | 0.36 | 0.64
Ab | PCR | p(F=R) | p(F=D)
REJECT | REJECT | - - | - -
DETECT | REJECT | - - | - -
REJECT | DETECT | - - | - -
DETECT | DETECT | - - | - -

FIG. 7

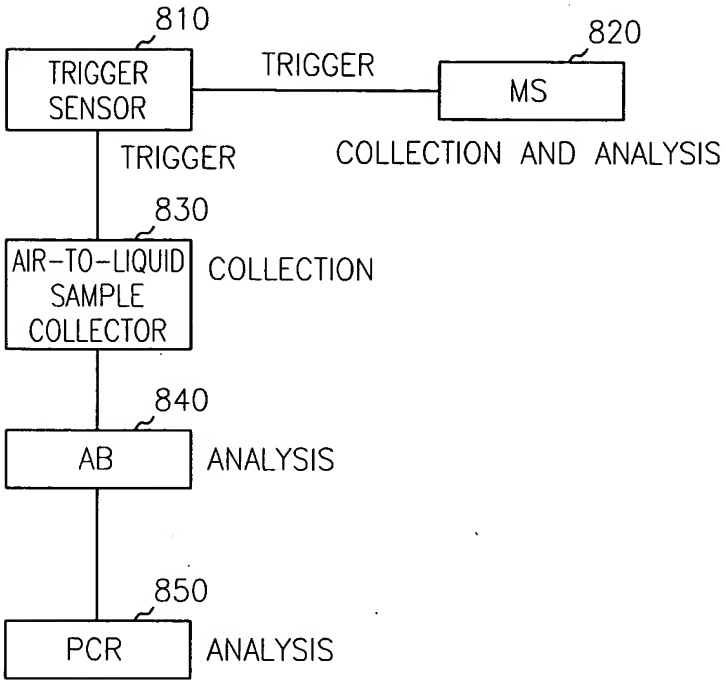
810
TRIGGER SENSOR
TRIGGER
820
MS
TRIGGER
COLLECTION AND ANALYSIS
830
AIR-TO-LIQUID SAMPLE COLLECTOR
COLLECTION
840
AB
ANALYSIS
850
PCR
ANALYSIS

FIG. 8A

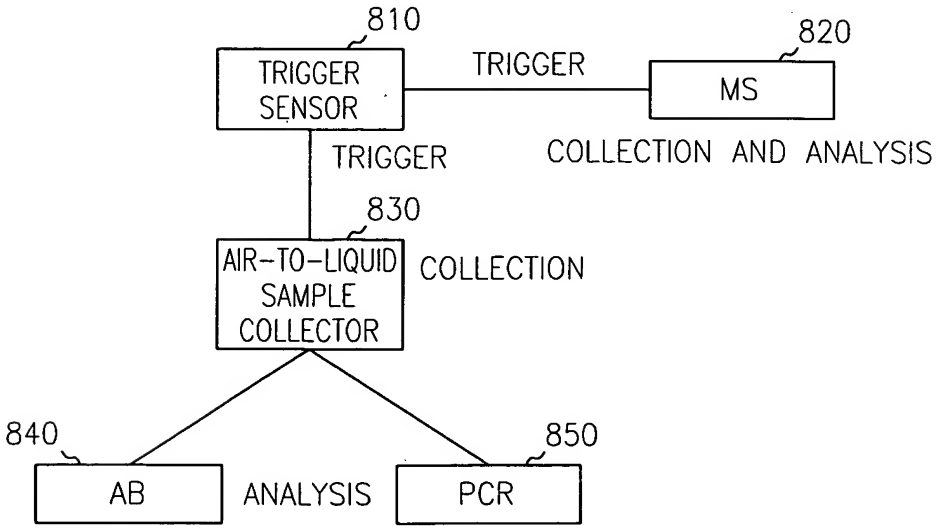
810
TRIGGER SENSOR
TRIGGER
820
MS
TRIGGER
COLLECTION AND ANALYSIS
830
AIR-TO-LIQUID SAMPLE COLLECTOR
COLLECTION
840
AB
ANALYSIS
850
PCR

FIG. 8B

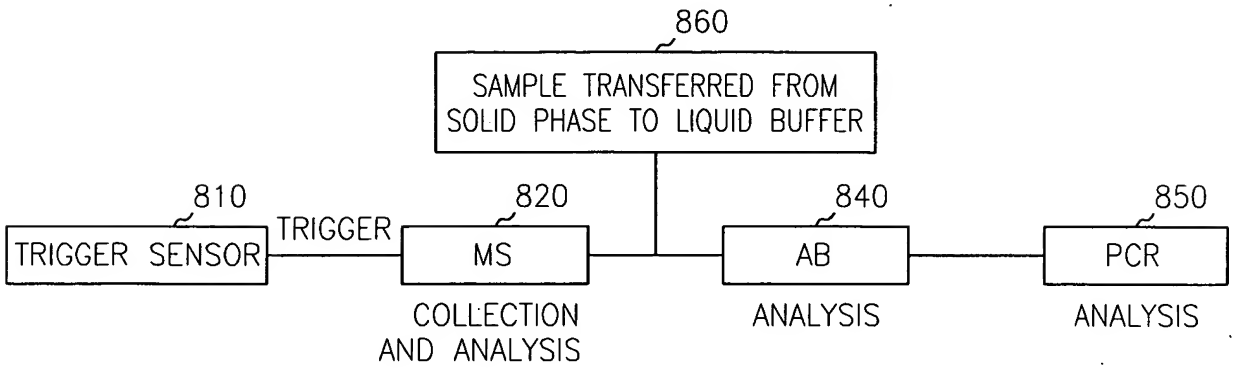
860
SAMPLE TRANSFERRED FROM SOLID PHASE TO LIQUID BUFFER
810
TRIGGER SENSOR
TRIGGER
820
MS
COLLECTION AND ANALYSIS
840
AB
ANALYSIS
850
PCR
ANALYSIS

FIG. 8C

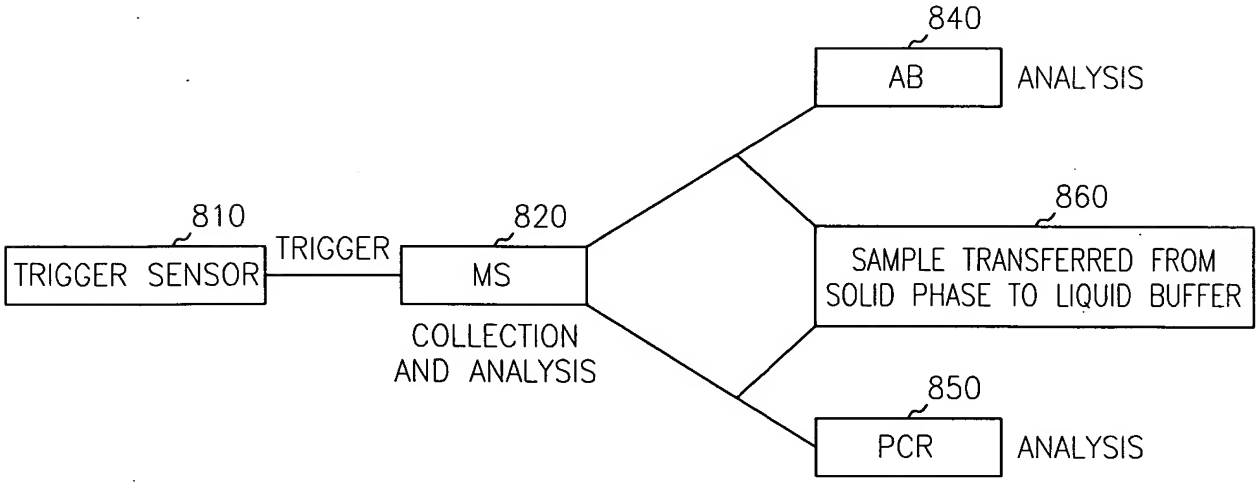
840
AB
ANALYSIS
860
SAMPLE TRANSFERRED FROM SOLID PHASE TO LIQUID BUFFER
810
TRIGGER SENSOR
TRIGGER
820
MS
COLLECTION AND ANALYSIS
850
PCR
ANALYSIS

FIG. 8D

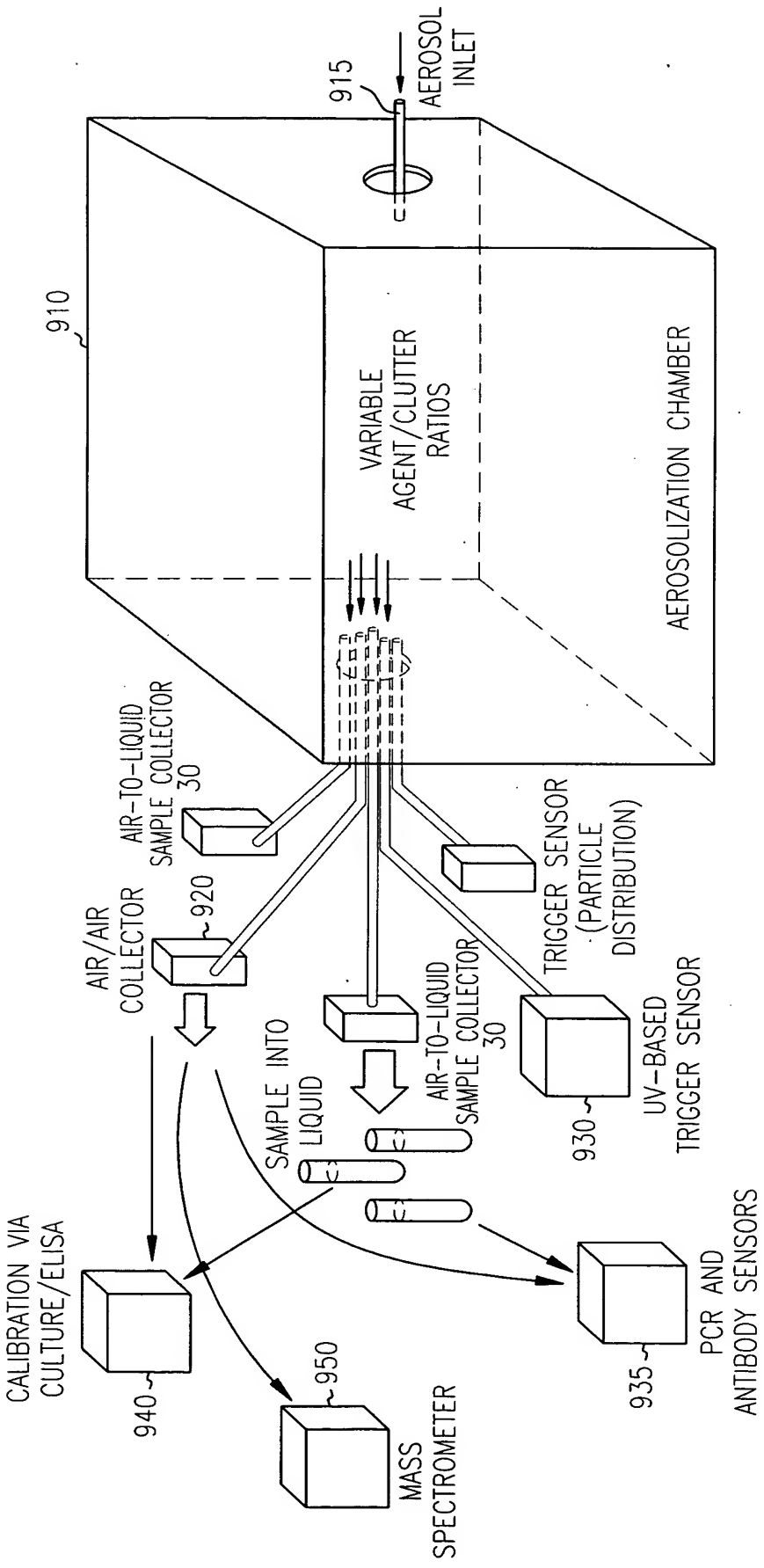
915
AEROSOL INLET
910
VARIABLE AGENT/CLUTTER RATIOS
AEROSOLIZATION CHAMBER
AIR-TO-LIQUID SAMPLE COLLECTOR 30
TRIGGER SENSOR (PARTICLE DISTRIBUTION)
AIR/AIR COLLECTOR
920
AIR-TO-LIQUID SAMPLE COLLECTOR 30
SAMPLE INTO LIQUID
UV-BASED TRIGGER SENSOR
930
CALIBRATION VIA CULTURE/ELISA
940
950
MASS SPECTROMETER
935
PCR AND ANTIBODY SENSORS

FIG. 9

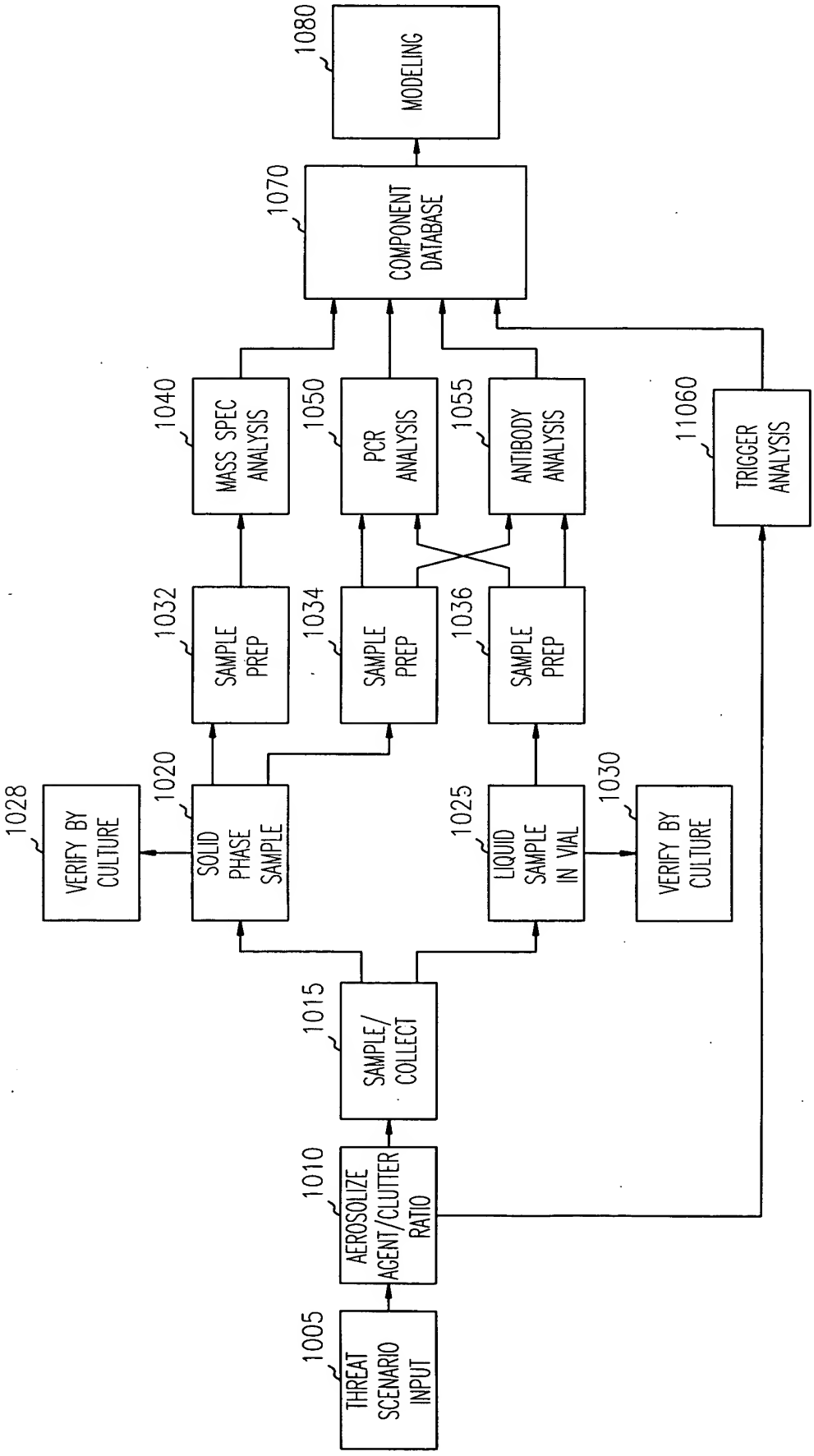
1080
MODELING
1070
COMPONENT DATABASE
1040
MASS SPEC ANALYSIS
1050
PCR ANALYSIS
1055
ANTIBODY ANALYSIS
11060
TRIGGER ANALYSIS
1032
SAMPLE PREP
1034
SAMPLE PREP
1036
SAMPLE PREP
1028
VERIFY BY CULTURE
1020
SOLID PHASE SAMPLE
1025
LIQUID SAMPLE IN VIAL
1030
VERIFY BY CULTURE
1015
SAMPLE/ COLLECT
1010
AEROSOLIZE AGENT/CLUTTER RATIO
1005
THREAT SCENARIO INPUT

FIG. 10

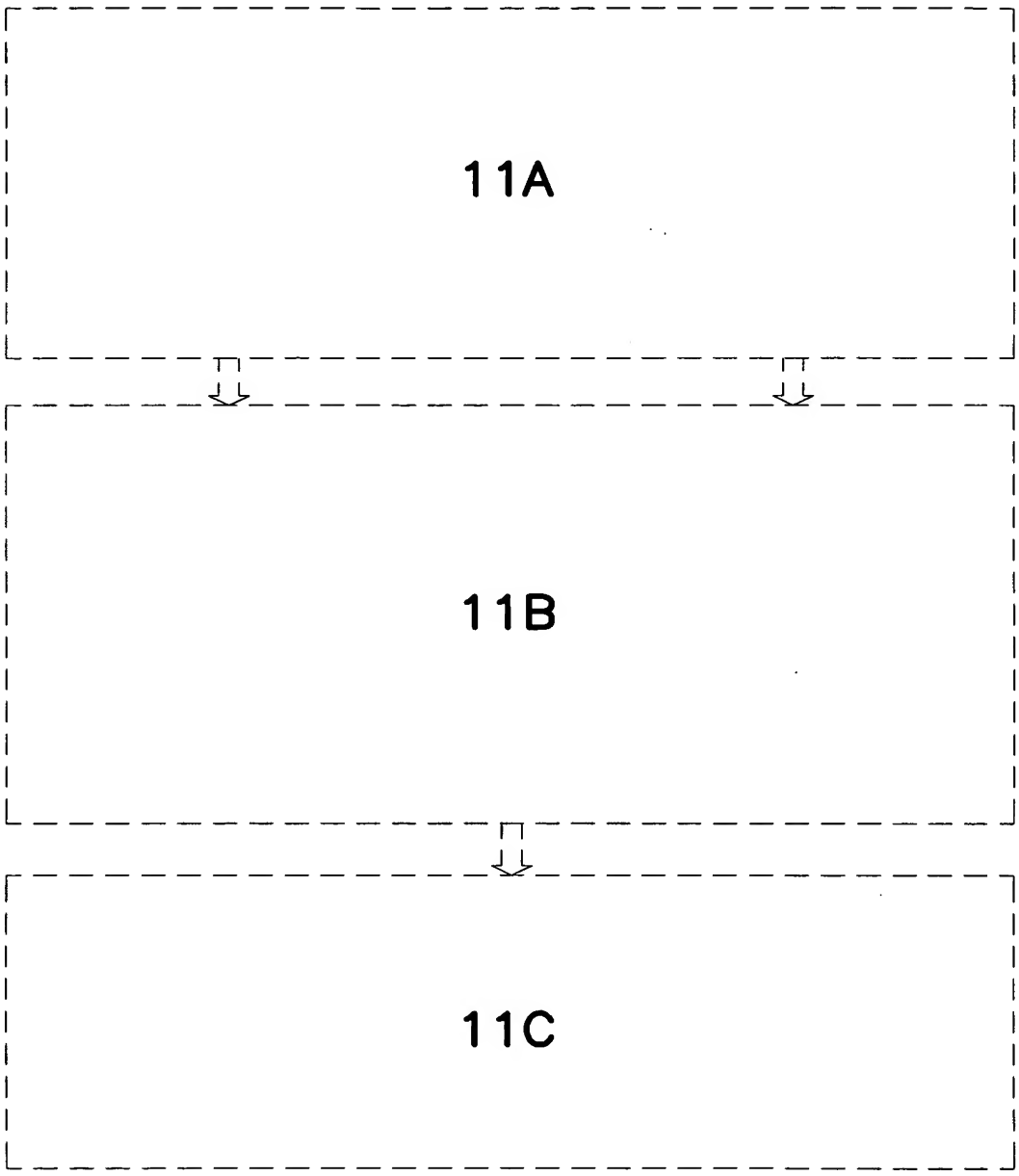

FIG. 11

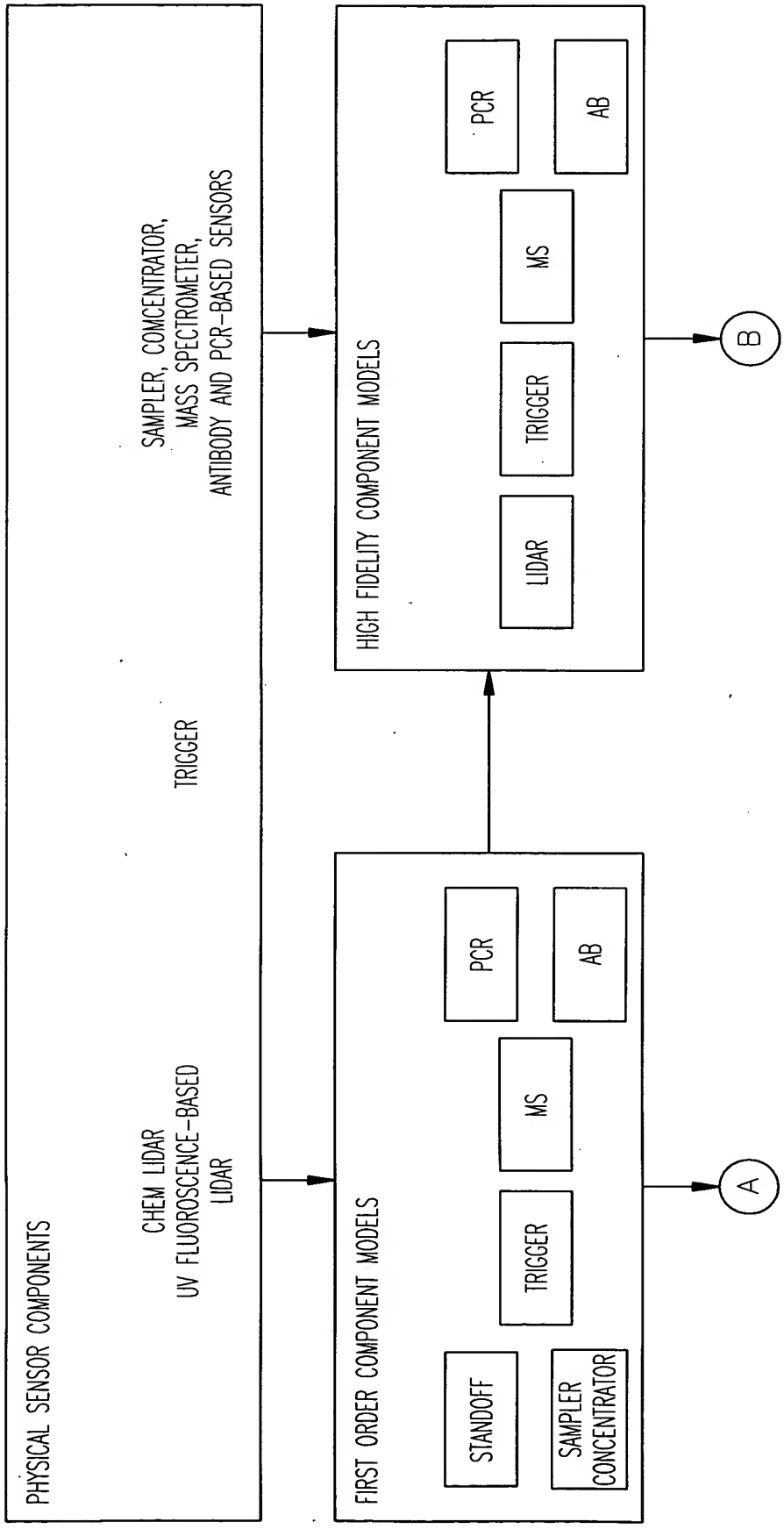
PHYSICAL SENSOR COMPONENTS
CHEM LIDAR
UV FLUOROSCENCE-BASED
LIDAR
TRIGGER
SAMPLER, COMCENTRATOR,
MASS SPECTROMETER,
ANTIBODY AND PCR-BASED SENSORS
FIRST ORDER COMPONENT MODELS
STANDOFF
SAMPLER
CONCENTRATOR
TRIGGER
MS
PCR
AB
A
HIGH FIDELITY COMPONENT MODELS
LIDAR
TRIGGER
MS
PCR
AB
B

FIG. 11A

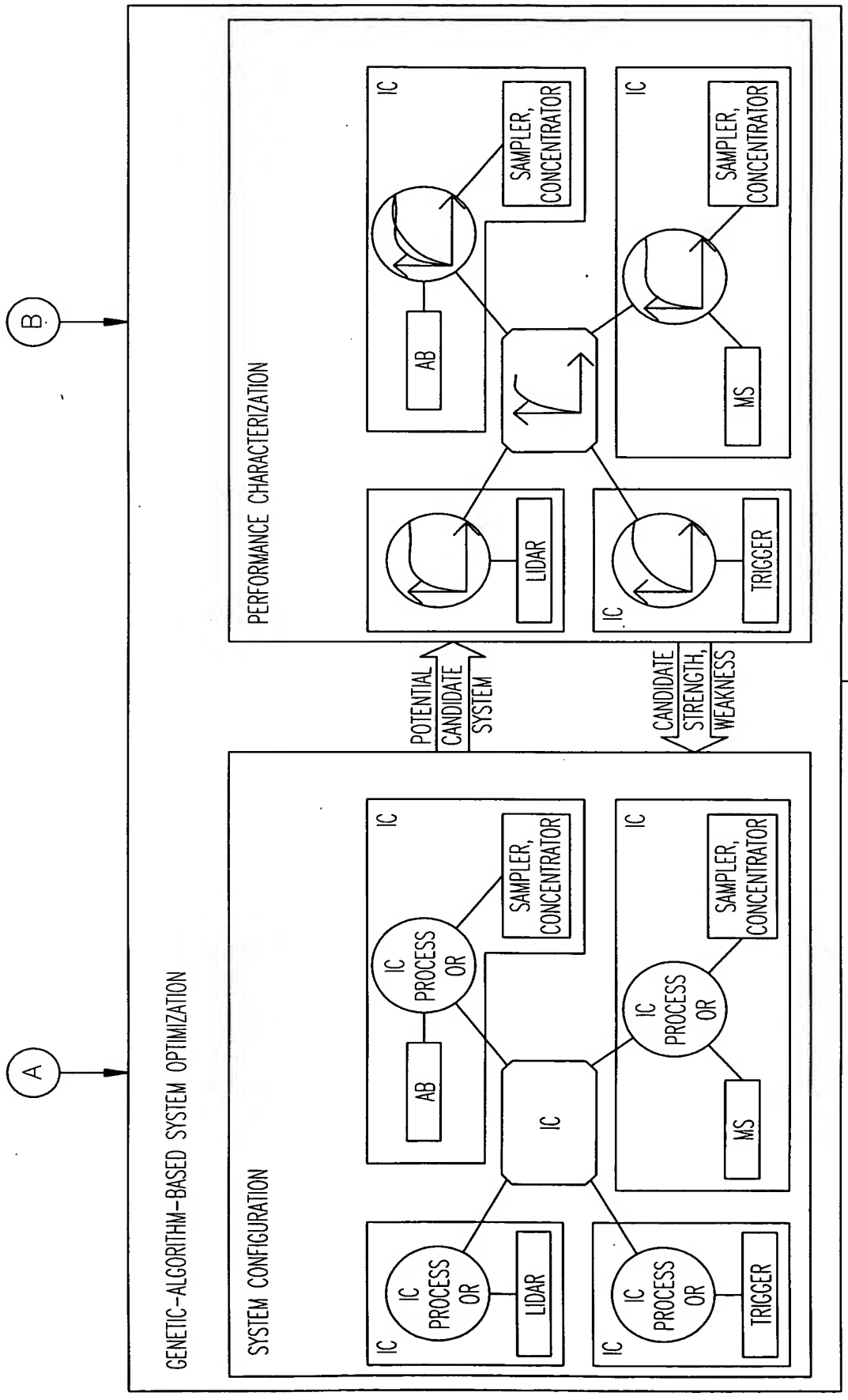
GENETIC-ALGORITHM-BASED SYSTEM OPTIMIZATION
A
B
C
SYSTEM CONFIGURATION
PERFORMANCE CHARACTERIZATION
IC
IC PROCESS OR
AB
SAMPLER, CONCENTRATOR
LIDAR
TRIGGER
MS
POTENTIAL CANDIDATE SYSTEM
CANDIDATE STRENGTH, WEAKNESS

FIG. 11B

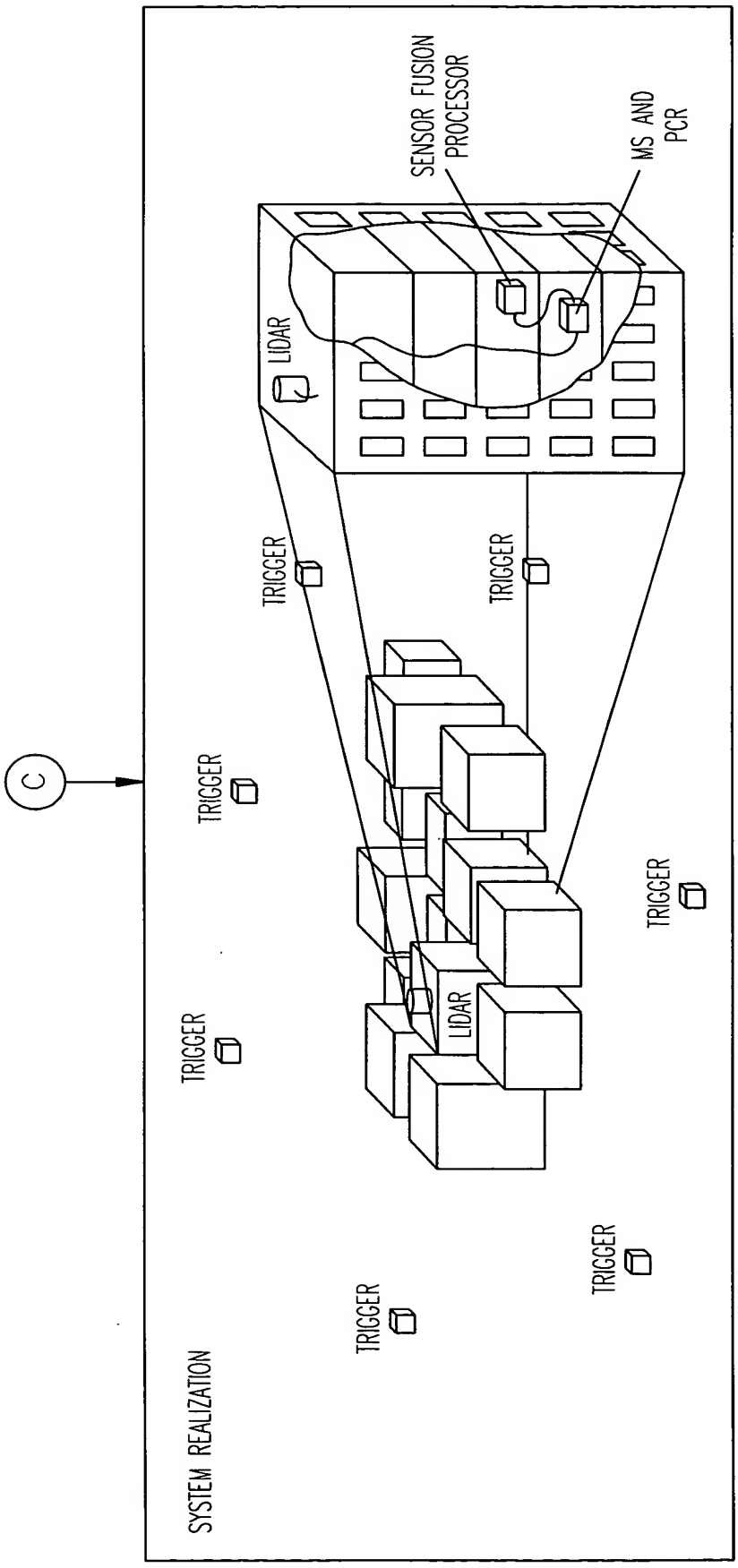
SYSTEM REALIZATION
C
TRIGGER
TRIGGER
TRIGGER
TRIGGER
TRIGGER
TRIGGER
LIDAR
LIDAR
SENSOR FUSION PROCESSOR
MS AND PCR

FIG. 11C

OPTIMIZATION PROCESS

VARY SYSTEM CONFIGURATIONS AND DETECTOR THRESHOLDS TO:

- MAXIMIZE PROBABILITY OF DETECTION (P_D)
- MINIMIZE PROBABILITY OF FALSE ALARM (P_{FA})
- MINIMIZE TIME OF RESPONSE (T_R)
- MINIMIZE CONSUMABLE COST ($)
- MAXIMIZE MEAN TIME BEFORE SERVICE (MTBS)

$$Q \sim \frac{P_D \bullet MTBS}{P_{FA} \bullet T_R \bullet \$}$$ 1310

Q = FIGURE OF MERIT FOR THE NETWORK

DETERMINE AND OPTIMIZE THE FIGURE OF MERIT DEPENDING UPON THREAT SCENARIOS

FIG. 12